



# CBCS SCHEME

17EE554

## Fifth Semester B.E. Degree Examination, Dec.2019/Jan.2020 Special Electrical Machines

Time: 3 hrs.

Max. Marks: 100

*Note: Answer any FIVE full questions, choosing ONE full question from each module.*

### Module-1

- 1 a. With a neat sketch, explain the construction of a 4 pole, two-phase, 15 rotor teeth hybrid stepper motor. With the help of switching circuit and excitation sequence, explain its working in one-phase ON mode and half-step mode. (10 Marks)
- b. Explain with a neat block diagram the closed-loop control of a stepper motor. (06 Marks)
- c. A stepper motor is wound for two phases and has 4 poles. It has 10 rotor poles. Find its revolution. (04 Marks)

OR

- 2 a. Derive the torque equation of a stepper motor. (08 Marks)
- b. Define the following: i) Step angle ii) Resolution iii) Stepping rate iv) Stepping error. (08 Marks)
- c. A permanent magnet stepper motor is driven by a series of pulses of duration 20ms. It has 4 stator poles and 6 rotor poles. How long will it take for the motor to make a complete revolution? (04 Marks)

### Module-2

- 3 a. List the four constraints on pole arc and tooth arc of switched reluctance motor. Draw L-θ diagram for 8/6 SRM assuming pole arc of 21° and 24° for the stator and rotor respectively. (10 Marks)
- b. With a neat circuit diagram and current and torque waveforms, explain the following types of BLDC motors i) One-phase and one-pulse and ii) One-phase and two-plane. (06 Marks)
- c. A 4-phase SRM has 6 rotor teeth. Find the step angle and commutation frequency for a speed of 6000rpm. Given the number of stator poles,  $N_s = 8$ . (04 Marks)

OR

- 4 a. With a neat sketch, explain the current regulators used for SRM. (08 Marks)
- b. Compare BLDC motor and conventional DC motor. (04 Marks)
- c. A permanent magnet DC motor has an armature resistance of  $1.03\Omega$ . It draws a current of 1.25A at no load with 50V supply and running at 2100rpm. Find: i) Speed-voltage constant ii) Rotational losses iii) Output power when it runs at 1700 rpm at 48V supply. (08 Marks)

### Module-3

- 5 a. Derive the emf equation of permanent magnet synchronous motor. (10 Marks)
- b. A 3-phase, 4 pole, 50Hz, 400V, star connected synchronous reluctance motor has direct axis and quadrature axis synchronous reactances of  $8\Omega$  and  $2\Omega$  respectively. For a load torque of 80N-m, find: i) Torque angle ii) Line current and iii) Power factor. Neglect armature resistance and mechanical losses. Given synchronous speed  $\omega_s = 50\pi$  rad/s. (10 Marks)

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.  
2. Any revealing of identification, appeal to evaluator and/or equations written eg, 42+8 = 50, will be treated as malpractice.

OR

- 6 a. With a neat diagram, explain the DSP-based control of PMSM. (07 Marks)  
 b. List any seven applications of synchronous reluctance motor. (07 Marks)  
 c. A 3-phase, 4 pole, star connected PMSM has 72 slots with 20 conductors/slot. The flux/pole is 0.05 Wb and the speed is 1500rpm. Assuming full pitched coil, find the phase and line voltage. Given distribution factor  $K_d = 0.986$ . Assume  $K_s = 1$ . (06 Marks)

Module-4

- 7 a. Derive the EMF equation of AC series motor. (10 Marks)  
 b. List the applications of universal motors. (04 Marks)  
 c. With a neat sketch, explain the constructional details of a drag cup AC servo motor. (06 Marks)

OR

- 8 a. Derive the voltage equation of a DC servo motor and draw the equivalent circuit. Plot the torque vs current and speed vs current characteristics of DC series motor and DC shunt motor. (10 Marks)  
 b. Explain with circuit diagrams the following speed control methods of universal motor:  
 i) Resistance method and ii) Auto-transformer method. (06 Marks)  
 c. List any four applications of single-phase reluctance motors. (04 Marks)

Module-5

- 9 a. Draw the phasor diagram of a Permanent Magnet Axial Flow motor (PMAF). Neglecting armature resistance and losses, derive the equation of the power developed in PMAF motor. (10 Marks)  
 b. With neat sketches, explain the construction of i) Homopolar DC linear motor and ii) Iron-cored DC linear motor. (06 Marks)  
 c. A vehicle is propelled by a linear induction motor. The motor has 100 poles with a pole pitch of 0.5m. Find the vehicle speed in kmph when the vehicle is running with a slip of 0.25 at a frequency of 50Hz. (04 Marks)

OR

- 10 a. With neat sketches, explain the construction of i) Single-sided PMAF machine and ii) Double-sided PMAF machine with internal PM rotor. (08 Marks)  
 b. Compare slotless and slotted linear synchronous motors. (04 Marks)  
 c. The thrust developed by a 3-phase linear induction motor is 100kN when running at 200Kmph. The supply frequency is 60Hz and the pole pitch is 0.5m. Determine the secondary copper loss. (08 Marks)

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